

**REMARKS**

Claims 1 and 4-15 are pending in the application. Claims 1, 4-14 are rejected. Claim 15 is withdrawn from consideration, and is herein canceled. New claims 19-28 have been added. No new matter has been entered.

**Claim Rejections - 35 U.S.C. §103(a)**

Claims 1, 4-6 and 14 are rejected under 35 U.S.C. §103(a) as being unpatentable over Yonehara et al. (US 2003/0159644 A1) in view of prior art as admitted by Applicants.

Claims 7-11 are rejected under 35 U.S.C. §103(a) as being unpatentable over Yonehara and APAA as applied to claim 2, above, and further in view of Fitzgerald (US 2002/0123167 A1).

Claim 12 is rejected under 35 U.S.C. §103(a) as being unpatentable over Yonehara et al. as and APAA applied to claim 1 above, and further in view of Hurley (5,698,474).

Claim 13 is rejected under 35 U.S.C. §103(a) as being unpatentable over Yonehara et al. and APAA applied to claim 1 above, and further in view of Steckl et al (5,759,908).

With respect to Applicants' previous traversals associated with the above rejections, the Examiner asserts that Applicants arguments filed January 22, 2007 have been considered but are not persuasive.

With regard to the amendment to the claim language, the Examiner asserts that the minimum boron concentration ([0149]) in the prior art and the required thickness is implemented after the boron concentration ([0149]-[0150]). Therefore, independent process steps determine

thickness and boron concentration and consequently the claim limitation as newly amended, i.e., “required thickness” “within said range of said boron concentration” is met by Yonehara et al.

Applicants note that the present invention claims a semiconductor substrate wherein, in part, a boron concentration is between  $5 \times 10^{16}$  (atoms/cm<sup>3</sup>) and  $2 \times 10^{17}$  (atoms/cm<sup>3</sup>), and a crystal layer is provided on the front face; and wherein a minimum value of the concentration of boron [B] is defined for a thickness t (μm) of the crystal layer boron based on a relational equation:  $[B] \geq (2.2 + 0.2) \times 10^{16} \exp(0.21t)$ .

Applicants herein argue (1) against the prima facie obviousness rejection, and (2) that evidence of unexpected results exists and has been proven for the claimed range.

Applicants applied the claimed equation to the range of overlap between the present invention and Yonehara to determine whether the thickness ranges of Yonehara et al. includes values that, when plugged into the above relational equation, satisfy the equation the equation for minimum boron concentration that fall in the claimed range and the range disclosed in Yonehara et al. Applicants calculated that a crystal layer thickness in the range of from 6.81 μm to 10.1 μm will satisfy the claimed equation of minimum boron concentration based on crystal layer thickness that fall in the claimed range and the range disclosed in Yonehara et al. Thus, the Examiner asserts that Yonehara et al. appears to suggest a substrate having a boron concentration in the claimed range and satisfying the equation.

Applicants first note that the Examiner is treating the claimed invention as having a single parameter, boron concentration, which claimed range overlaps that of Yonehara et al. Applicants respectfully disagree with this characterization. The present invention requires that a

minimum boron concentration in the substrate is dependent on the thickness of the substrate, and subject to a specific range of boron concentration. Thus, it is two parameters that must be met by any prior art. While the Examiner may assert that selecting a boron concentration and substrate layer thickness is merely optimizing the prior art, Applicants note that such rationale is based on optimizing a known result-effective value; that is, a value that when varied causes a known result. However, there does not appear to be any motivation in Yonehara et al. to use any particular value of boron concentration and any particular thickness of substrate layer.

Applicants calculated that a crystal layer thickness in the range of from 6.81  $\mu\text{m}$  to 10.1  $\mu\text{m}$  will satisfy the claimed equation of minimum boron concentration based on crystal layer thickness that fall in the claimed range and the range disclosed in Yonehara et al. Thus, the Examiner asserts that Yonehara et al. appears to suggest a substrate having a boron concentration in the claimed range and satisfying the equation.

Since the range of possible boron concentration of Yonehara et al that overlaps that of the present invention is:

(range of Yonehara et al. that meets present invention)/(range disclosed in Yonehara et al.)

$$(2 \times 10^{17} - 1 \times 10^{17}) / (1 \times 10^{20} - 1 \times 10^{17})) = 0.1\%,$$

and since the range of substrate layer thickness of Yonehara et al. that would then meet the claimed equation is

(range of Yonehara et al. that meets present invention)/(range disclosed in Yonehara et al.)

$$(10.1 \mu\text{m} - 6.81 \mu\text{m}) / (20 \mu\text{m} - 0.1 \mu\text{m}) = 16.5\%$$

the chance of a randomly selected boron concentration and substrate layer thickness from Yonehara et al. meeting the claimed boron concentration and substrate layer thickness is 0.0165%, or less than 1 in 6,000. Given that there is no shown or asserted teaching toward any particular boron concentration or any particular thickness of substrate in the disclosed ranges of the cited reference, such small probability indicates that there is essentially no suggestion to use parameters that will meet the claimed invention. Thus, Applicants respectfully disagree that the present invention is suggested by the asserted prior art.

Furthermore, Applicants point to evidence of unexpected results in the claimed range. The Examiner has previously discounted the assertion of unexpected results as not commensurate in scope with the ranges of the claimed invention. However, Applicants believe that such assertion of the Examiner is mistaken.

With respect to the rationale for the upper limit of  $2 \times 10^{17}$  (atoms/cm<sup>3</sup>) boron, the specification itself indicates that the upper limit is based on the present Inventors' finding that silicon substrates having boron concentrations of  $2 \times 10^{17}$  (atoms/cm<sup>3</sup>) or lower can be evaluated as having no autodoping problem. Such lack of autodoping is not contemplated by Yonehara et al., nor would it be expected in light of Yonehara et al. teaching that the entire range of  $10^{17}$  to  $10^{20}$  (atoms/cm<sup>3</sup>) is equivalent. Such lack of autodoping problem is evident throughout Applicants' claimed range of  $5 \times 10^{16}$  (atoms/cm<sup>3</sup>) to  $2 \times 10^{17}$  (atoms/cm<sup>3</sup>).

Applicants have further previously submitted that the claimed range of boron results in further unexpected results associated with high gettering ability for iron atoms (as mentioned in specification) and also for nickel atoms within a range of the boron in the claimed range. The Examiner has discounted this evidence as not commensurate with results. Applicants submit that this evidence, combined with the above-noted stronger evidence of unexpected results associated with the upper limit of  $2 \times 10^{17}$  (atoms/cm<sup>3</sup>) of boron should suffice in rebutting the obviousness rejection, if such rejection is indeed valid.

In addition to the above, Applicants herein add new claims 19-28, corresponding to claims 1 and 4-12, but with the limitation from claim 13 added thereto. Applicants submit that no new matter has been entered. Applicants submit that there is no disclosure or suggestion in Yonehara and the other cited references that the contents of claim and "carbon is contained at a concentration of  $1 \times 10^{15}$  (atoms/ cm<sup>3</sup>) or higher" in substrate.

In view of the aforementioned amendments and accompanying remarks, Applicants submit that that the claims, as herein amended, are in condition for allowance. Applicants request such action at an early date.


If the Examiner believes that this application is not now in condition for allowance, the Examiner is requested to contact Applicants' undersigned attorney to arrange for an interview to expedite the disposition of this case.

Application No. 10/743,793  
Attorney Docket No. 032206

Amendment under 37 C.F.R. §1.111  
Amendment filed May 7, 2007

If this paper is not timely filed, Applicants respectfully petition for an appropriate extension of time. The fees for such an extension or any other fees that may be due with respect to this paper may be charged to Deposit Account No. 50-2866.

Respectfully submitted,  
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